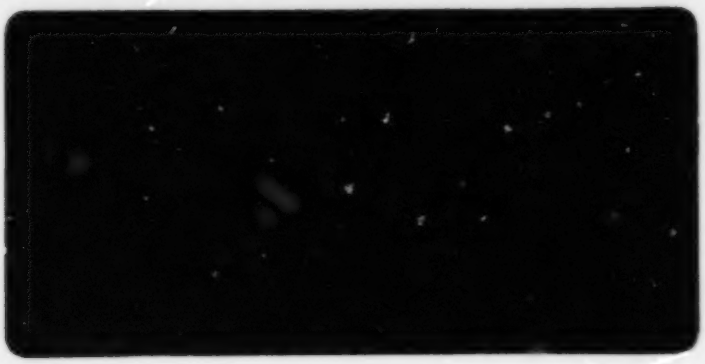
DEFECT INVESTIGATIONS



Enquêtes sur des défauts de véhicules

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TRANSPORT CANADA
DEFECT INVESTIGATION
ROAD SAFETY AND MOTOR VEHICLE
REGULATION DIRECTORATE

INVESTIGATION OF "SUDDEN ACCELERATION" INCIDENTS

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By: PAUL MARRINER, P. ENG.
CHIEF, DEFECT INVESTIGATION

and JOHN GRANERY
SENIOR INVESTIGATOR
DEFECT INVESTIGATION DIVISION

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17. Abstract

"Sudden acceleration" is a phenomenon which has received considerable attention during the past several years. For the purposes of this report "Sudden Acceleration"(S.A.) is defined as an incident conforming to the following pattern: 1) vehicle's automatic transmission is in the "park" or "neutral" position; 2) vehicle is started by driver or is at idle; 3) driver shifts from "park" or "neutral" to "reverse" or "drive"; 4) vehicle accelerates rapidly, apparently without driver input; and 5) brakes are reported to be ineffective.

The report discusses the history of various government bodies' involvement in the investigation of such incidents, the results of studies and investigations, and the present position of governments and manufacturers concerning these incidents.

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INTRODUCTION

"Sudden acceleration" is a phenomenon which has received considerable attention during the past several years. For the purposes of this report "Sudden Acceleration" (S.A.) is defined as an incident conforming to the following pattern: 1) vehicle's automatic transmission is in the "park" or "neutral" position; 2) vehicle is started by driver or is at idle; 3) driver shifts from "park" or "neutral" to "reverse" or "drive"; 4) vehicle accelerates rapidly, apparently without driver input; and 5) brakes are reported to be ineffective.

This report will discuss the history of various government bodies' involvement in the investigation of such incidents, the results of studies and investigations, and the present position of governments and manufacturers concerning these incidents.

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SECTION I

TECHNICAL BACKGROUND

1. FUEL SYSTEMS

Until recently, most vehicles used a carburetor to mix fuel with the correct quantity of air to support combustion. Within certain limitations, this device is capable of maintaining the required air/fuel mixture through a wide range of engine operation. In these systems, a throttle valve is actuated by an accelerator pedal. As an operator depresses the pedal, an increasing amount of air, along with the correct proportion of fuel will enter the engine and result in increased engine speed and horsepower. In most designs, when the pedal is released, the throttle valve is held slightly open to permit an engine idling speed. An engine must have air to operate, additional fuel by itself will not result in an increased engine speed (RPM).

When cold, an engine requires more than the normal amount of fuel while starting, and once started, it may require a higher idle speed and extra fuel until it has reached operating temperature. The air/fuel mixture is usually increased or enriched by means of an automatic choke. During this time the throttle valve is held further open than during normal idle, resulting in a "fast idle" speed. The

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engine will return to normal idle speed once it has reached its designed operating temperature. Some carburetor equipped vehicles may use a throttle valve solenoid to stabilize idle speed, as required by the extra loads exerted on the engine by accessory equipment such as an air conditioning compressor.

Vehicles that operate on propane or compressed natural gas use special gas regulators, but are similar in that a throttle valve must be opened to admit an air/fuel mixture. It is this valve that determines engine speed.

Recently, more vehicle engines are equipped with fuel injection. It would be impractical to attempt to describe in detail all the various designs presently in use, but what follows is a general outline of fuel injection operation. Fuel injection systems perform the same duty as carburetors, but more efficiently. They were introduced mainly to improve control of exhaust emissions, but have now resulted in better fuel economy and driveability. Newer systems are electronically controlled, and some operate in conjunction with an onboard computerized engine management system. All fuel injection systems utilize a throttle valve similar to that in a carburetor. The throttle valve, which must be opened to admit air or the air/fuel mixture, is

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actuated by an accelerator pedal, and on most systems is completely closed at idle. In order to permit engine idle a throttle bypass device delivers a metered amount of air around the throttle valve. This air bypass is usually controlled electrically or electronically to meet engine requirements such as cold fast idle. Additional engine idle speed stabilization to compensate for air conditioning compressor and alternator load, ignition timing, temperature and pressure variations may be included.

Some systems employ several bypass and/or compensation valves, controlling separate functions and idle stabilization requirements. The trend of late however, is to a larger single unit. The idle compensating valve or throttle bypass on fuel injected vehicles is independent of the throttle valve. It cannot cause an engine to attain maximum RPM and power. The worst-case compound failure scenario of a throttle bypass system is an excessive idle speed.

Previous investigations demonstrated that if an accelerator pedal is connected to the throttle valve through a direct actuating rod or lever, movement of the engine or power train in relation to the accelerator pedal attachment would result in unwanted throttle valve application. Most modern vehicles use a cable rather than rods and levers to eliminate this problem.

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2. AUTOMATIC TRANSMISSIONS

Most modern passenger cars with automatic transmissions have at least three speeds. Sometimes a fourth speed - occasionally referred to as overdrive - is included. As previously described, when an operator depresses the accelerator pedal, the linkage starts to open the throttle valve. At the same time a linkage actuated by the accelerator pedal moves an internal hydraulic valve in the transmission. This determines the shift points or gear shift timing. A light accelerator pedal application will result in relatively quick gear upshift, whereas a heavier pedal application delays gear changes. When demanding maximum horsepower and speed by fully depressing the accelerator, the valve will, under certain engine and/or road speeds, cause the transmission to downshift, such as during passing or hill climbing.

It is impossible for modern vehicles to furnish hydraulic feedback through this transmission valve that would result in increased engine speed because a "one-way" feature is either internally designed or incorporated in the linkage to the throttle valve.

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3. BRAKE SYSTEMS

All passenger cars and trucks, except heavy duty air brake type trucks, are equipped with hydraulically activated brakes, and are known simply as "hydraulic brakes". In most cases they are equipped with either vacuum or hydraulic power assist. A few truck configurations may have compressed air power assisted hydraulic brakes. All modern hydraulic brakes are split into two separate subsystems that usually service one half of the vehicles braking system. Each portion has a separate fluid reservoir that may serve either two front wheels or two rear wheels, or one front wheel and the opposite rear wheel (the latter is known as a cross split configuration). There are other little used variations such as each of the two separate subsystems serving both front wheels and one rear wheel. In the event of a partial hydraulic system failure, one half of the vehicle braking system will remain operational. It is extremely unusual for a total hydraulic system failure to occur. A partial system failure will result in lower brake pedal height, increased pedal effort and stopping distance, and activation of a warning light.

Air brakes used on modern heavy duty trucks will not be discussed here, except that they also employ two subsystems. In the event of partial failure some braking effect is retained. In addition, emergency braking is provided in the event of total loss of air.

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Most current vehicles are equipped with power brakes. Power assist is usually provided by engine vacuum, but some types obtain assist from power steering hydraulics. In both vacuum and hydraulically assisted systems, the vehicle engine must be operating, however both types usually provide some form of backup should an engine fail. On vacuum assisted systems, the power assist servo chamber is equipped with a check valve that closes when engine vacuum decreases. The available vacuum that exists in the servo chamber will usually provide at least two or three power assisted stops. Some complex vacuum systems may also be equipped with a reserve tank, and/or an electrically operated vacuum pump. These auxiliary backup systems are designed to provide extended power assist in the event of vacuum loss or engine failure.

As a throttle valve is opened (accelerator pedal depressed), available engine vacuum is diminished. An engine may provide little or no vacuum at wide open throttle. In the event of a wide open throttle condition on a vehicle equipped with vacuum assisted power brakes, and without an auxiliary pump or reservoir, an operator could deplete the vacuum reserve by cycling the brake pedal several times. This could result in a loss of power assist. In other words, if the accelerator pedal is held depressed while pumping the brake pedal, the pedal effort required to stop a vehicle could be increased.

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Hydraulically assisted brake systems are powered by a belt driven pump that is usually shared with power steering. Backup equipment includes an electrically operated pump, and/or a spring loaded or nitrogen charged accumulator cylinder. These backup systems are usually standard equipment on hydraulically assisted brakes because a power steering belt failure as well as an engine failure could result in loss of assist. In the event of power assist failure, increased pedal effort and stopping distance may occur.

Some modern vehicles are equipped with an anti-lock braking system (ABS). ABS was developed to decrease vehicle stopping distances and improve vehicle stability and directional control by reducing wheel lock under most braking conditions. There are many variations of ABS and it is available on cars and trucks, including HD air brake type trucks. Hard or emergency braking is usually required before ABS becomes active and a failure in an ABS system will not result in loss of brakes.

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4. CRUISE CONTROL

Cruise control or automatic speed control devices on modern automobiles are designed, under normal driving conditions, to automatically maintain a desired vehicle speed pre-selected by a driver. No input through the accelerator pedal is required. The systems are intended to reduce driver fatigue and improve fuel economy, and are available on cars and trucks with both standard and automatic transmissions. When a driver wishes to cancel a previously programmed cruise control setting, he need only depress the brake pedal.

Cruise control systems have been installed on some vehicles since the early 1960s. They were electro-mechanical, but not electronic, devices, some of which used engine vacuum to actuate the throttle or accelerator pedal. Most of today's vehicles use a micro-processor (ECM) to control the system. While some continue to employ vacuum, other systems use compressed air or an electric motor to actuate the throttle.

In addition to the ignition switch, driver controls are an "on/off" switch, a "set" or "engage" pushbutton that sometimes doubles as a "decel" control, and a "resume" control.

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The function of these controls will be described in a later paragraph. These controls are usually combined,and located either on the turn signal lever or the horn pad. Some vehicles are equipped with a separate on/off switch on the dashboard that in some designs, switches the system off automatically when the ignition key is turned off. This type must be manually reset before the cruise control can be used, and is designed to eliminate inadvertent engagement.

Vehicle inputs to the ECM may include: (1) Road speed, which usually is a pulse obtained from the speedometer or speedometer drive, but can be obtained with a magnetic pickup at the drive shaft, front axle or wheel... (2) Power supply, which is usually routed from the ignition switch through the on/off switch... (3) Engine speed (RPM), obtained from the ignition distributor or electronic ignition control module... (4) An electrical cancel signal, obtained from the stoplight switch, and sent to the ECM when the brake pedal is depressed... (5) An electrical engage signal, interupted by a switch that is actuated when the brake pedal is depressed -this circuit may be independent, or in series with other controls which are interupted when; (a) the clutch pedal is depressed on manual transmission vehicles, (b) when the gearshift lever is in neutral position on automatics, (c) when the engine reaches maximum allowable RPM.

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In systems that use engine vacuum to power the servo motor, the vacuum may dump or vent to atmosphere by means of a mechanical valve, opened when the brake pedal is depressed. This deactivates the cruise control as long as the pedal is depressed, and is independant of all electronic functions.

In most cases two, but sometimes three, completely separate systems are capable of cancelling a cruise control setting when the brake pedal is depressed, ie. (1) an electrical engage signal is interupted, (2) a separate electrical cancel signal is sent to the ECM, and (3) the vacuum servo-motor may be mechanically vented.

Cruise control systems using ECMs are designed so that if an electronic failure were to occur, it could only result in the system deactivation. Most generate two separate output signals to the servo motor which are constantly being compared, and any discrepancy will result in shutdown. Some systems use additional circuitry that monitors both input and output ECM signals and is designed to deactivate if any are missing, illogical or spurious.

On several systems using vacuum or compressed air, the servo-motor actuation chamber is exhausted by two independant solenoid valves, controlled by separate ECM outputs.

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If one of these valves were to fail in the closed position, the other is capable of system deactivation. If either or both were to fail in the open mode, the system could not operate. In most cases the servo-motor actuates the throttle by means of a cable that is connected to the throttle valve, but it may be attached directly to the gas pedal on some designs.

All cruise control systems are designed so they cannot be engaged until the vehicle has obtained "minimum engage speed," about 40 to 50 Km/h, (25 to 30 mph). This feature is intended to eliminate the possibility of inadvertent engagement at a time when there is an existing "set" speed in memory. When a driver engages cruise control at a given road speed, that speed will be retained in memory. The command can be cancelled by applying the brakes. To resume engagement at the previous speed, the vehicle must be acclerated manually until it has attained the minimum engage speed, then the resume control must be used. The system will engage and the vehicle will accelerate to the last memory setting.

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The decel mode will cause the vehicle to slow down as long as the pushbutton is depressed. Once released, the system will reset and reengage, and the new updated speed setting will be retained in the memory. A newer driver control feature on some systems is the "cancel" button, which will deactivate the cruise control without brake application, and the preset speed will be retained in the memory.

In most systems, any speed setting retained in the memory will be lost if the on/off switch or the ignition switch is turned off. A new speed setting will then have to be entered in memory before the resume feature can be used. All cruise control systems will disengage if the ignition key is turned off, but the vehicle will lose all engine power, power steering and most most will lose power brake assist after several pedal applications. The steering wheel may also lock.

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SECTION II

PREVIOUS INVESTIGATIONS

1. DEFECT INVESTIGATION DIVISION - TRANSPORT CANADA

Transport Canada received its first complaint of "sudden acceleration" (S.A.) in 1977 and it involved a 1974 Buick Century. As of the date of this report, there have been 245 incidents reported to this office. In 1978 the Defect Investigation Division opened a major investigation into the alleged S.A. of General Motors vehicles which appeared to be overrepresented at that time. A contract was let to Prof. F.W. Black of Carleton University to examine four General Motors vehicles reported to have experienced the condition and to attempt to reproduce an S.A. on a government test vehicle by creating faults in the cruise control system. During the same period TES Limited, an engineering consultant firm, was tasked to preform repeated starting operations on a vehicle which had experienced an incident.

The William Black Limited report submitted 12 March 1979 (vehicles examined - 1975 Pontiac Parisienne, 1978 GMC Jimmy, 1975 Oldsmobile, 1977 Malibu Classic; test vehicle - 1978 Buick Century) found that:

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1) no source of air exists, except for the throttle, which could produce engine power at a level necessary to reproduce the incidents;

2) the Jimmy and the Malibu had all systems functioning normally;

3) the Parisienne had a malfunctioning brake-actuated vacuum release valve but this could not result in a S.A. condition;

4) a cruise control system malfunction was detected on one occasion with the Oldsmobile such that when the vehicle reached a simulated 30 mph the throttle went wide open without pressing the engagement switch. As this situation could have resulted from a failure to adequately trigger the electric brake release switch before restarting the simulation, it was not considered significant.

The TES Limited investigation did not succeed in recreating a problem.

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In November of 1986 Transport Canada closed its investigation into General Motors sudden acceleration incidents on the basis that no mechanical fault had been found which could explain the cases. The closing report stated that operator pedal error was the most likely cause of the incidents.

As a result of a large number of reports alleging S.A. incidents involving Honda Accords, T.C. opened an investigation of these vehicles in January of 1987. No information was developed during this investigation which indicates any form of mechanical defect and it was closed in April 1988. The fact that most complaints originated from the Ottawa and Toronto areas following considerable publicity of several incidents, may be significant.

During the years 1982-1986 the Defect Investigation Division collected 92 accident reports from the Regional Municipality of Ottawa-Carleton which involved an S.A. but which were admitted by the operator or determined by the investigating police officer to involve a pedal error. The data collected is displayed in the Appendix. Percent of total incidents by manufacturer is shown in Graph 1, incidents per 10,000 vehicles in the manufacturers fleet (estimated from total fleet sales) in the Ottawa/Carleton Region in Graph 2, and incidents by age group in Graph 3.

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Graph 2 should be viewed with caution in cases where a manufacturer's vehicles have experienced only one or two incidents as a small fleet size will overemphasize the rate per 10,000 vehicles. It is worthy of note that the major manufacturers are quite evenly represented.

Graph 3 indicates that in this study the eldest and youngest drivers were over-represented.

The investigation of the Audi 5000 automobile by Transport Canada and the Office of Defect Investigation, National Highway Traffic Safety Administration and the enormous amount of publicity which the case generated deserves a detailed examination. In the early 1980's reports of S.A. incidents involving Audi 5000s began to increase in both Canada and the U.S.A. In two separate actions, Audi attempted to adjust pedal location and eliminate a possible floormat/accelerator pedal interference. The first clearly assumed driver error as the cause and was an attempt to alter the foot/pedal environment so as to reduce pedal mix-up. The second remedied an identified problem which could <u>not</u>, without the addition of an operator error, result in an S.A. as previously defined.

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Regardless of these actions the incident rate continued unabated. One contributing factor was that the sophisticated Audi 5000 engine control system employed a device known as an idle air control valve which was described in Section I. Numerous problems existed with this device which could, perhaps in conjunction with other conditions such as a partially stuck throttle, cause very high (over 4000 rpm) engine idle speeds. Under no conditions however would the vehicle's very powerful braking system be affected. The extensive investigation by both governments did not uncover any mechanical defects which could result in an S.A. Audi carried out an extensive pedal placement comparison which revealed nothing remarkable and commissioned a thorough study of the engine control and brake system by the Battelle Institute. The latter confirmed that there was no mechanism in the Audi design which could create a simultaneous, undetectable, failure of the engine and braking systems. Battele engineers were, however, able to create a fault in the cruise control system which would open the throttle at zero speed if the cruise control power switch was on and the brake was released. Reapplication of the brake immediately returned the throttle to idle (more on this further on). Unfortunately,

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Battelle used the term "unintended acceleration" for what this report calls "sudden acceleration" which could lead to confusion. In any event the report concludes that "this Battelle analysis did not reveal a design malfunction nor safety defect in the Audi 5000 C2 and C3 cars which could cause an "unintended acceleration" incident (i.e. simultaneous vehicle acceleration and loss of braking effectiveness)".

Regardless of this evidence, in the face of a rapidly deteriorating situation in the marketplace, Audi decided to recall all the vehicles in question to install a shift-lock device and attempt to correct the idle air control valve problems. The shift-lock device prevented a driver from shifting from park to any other gear unless his foot was on the brake pedal. This remedy was a straightforward attempt to prevent pedal errors.

Both governments welcomed this move as it clearly addressed the problem as identified by the current and previous investigations. As well, an expected decrease in the number of incidents should have provided a convincing argument in favor of the pedal error cause conclusion. In Canada this was the case, as to date no cases have been reported during the last two years, as compared with some 51 in the years preceding the installation of the shift-lock.

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In the U.S., as far as the press and other non-governmental organizations are concerned, the situation is different. There are three major reasons for this phenomenon. The primary one is the confounding presence of significant problems with unstable idle as mentioned before. These continue to be reported as S.A. cases. The second is a spate of claims intended to exculpate the operator from responsibility for accidents. Many involve bizarre scenarios in order to explain why the shift-lock did not prevent the incident. In addition, certain groups continue to report incidents in the preceding categories without any explanation or investigation. The third reason was that certain incidents involve a malfunctioning shift-lock, usually due to improper installation by the dealer involved.

In conclusion, the Audi investigation and resulting recall in Canada has provided the first positive affirmation that SA results from operator error. Parenthetically it should be noted that Nissan recalled their 1979-1987 280z and 300zx models to install shift-locks in July 1987. Prior to the recall Transport Canada had received two complaints of S.A. in the subject population. None have been reported since.

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2. OFFICE OF DEFECTS INVESTIGATION - NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION (ODI)

Since 1967 the Office of Defects Investigation of the National Highway Traffic Safety Administration (NHTSA) has opened more than twenty investigations into allegations of S.A. Of these, five related to engine mount failures, which, if the engine was capable of rotating, could open the throttle, one concerned a defective cruise control module which could cause the throttle to open when the brake was released, and another concerned a brake/ throttle cable interference which could open the throttle when brake was applied. All of these conditions were repeatable and detectable, and where failure rates were significant, the affected vehicles were recalled and repaired. Two investigations involving Audi vehicles have been discussed previously, and seven were closed from lack of evidence of a mechanical defect, including a major General Motors investigation which will be discussed separately. There are six investigations which remain open.

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It must be noted that while there were, in the cases where a specific mechanical defect was determined, complaints fitting the definition of S.A. given in the introduction, at no time were the vehicle brakes found to be inoperative. In short, the brakes, when they were in a properly maintained state, would stop the vehicle.

ODI conducted a major investigation into reports of S.A. incidents involving automatic transmission equipped General Motors' vehicles. The investigation was opened in August of 1978 and closed in August of 1986. A comprehensive closure report was prepared in which several interesting conclusions were drawn. One is that "GM claims and available facts indicate that a driver who believes he or she is pushing on the brake pedal would continue to push on the same pedal in an emergency situation, even if this belief is incorrect, and might persist in this incorrect belief even after the vehicle had crashed".

Testing included establishing that "shift linkage motion cannot impart motion to the throttle linkage". Two studies of pedal location and force-displacement characteristics which might contribute to the subject problem found that there was "no apparent correlation between any of the measured parameters and the relevant

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accident rate was found". Further, numerous tests of the type carried out by Transport Canada, established that properly maintained vehicle brakes will overpower the engine and bring a vehicle to a stop regardless of the conditions including complete loss of power assist.

The evidence presented against a mechanical defect being the cause of all but a few of the reported GM incidents is summarized as follows:

1) Inspection and test of involved vehicles by ODI, ODI contractors, Transport Canada, police accident investigation specialists and private investigators "did not result in the discovery of a relevant mechanical cause".

2) Even a relatively weak person can bring a GM vehicle accelerating under full throttle conditions to a stop with the vehicle brakes.

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3) In almost all cases, the involved vehicles which were repaired after the incident never experienced a reoccurrence of the problem. "This means that a mechanical cause, if present, would have had to induce the engine to suddenly malfunction and produce full power, the brakes had to fail at the same time, and both problems had to disappear or become self-corrected".

4) Vehicle diversity including different fuel delivery systems, brake system designs, engine control electronics, emission control systems, and cruise control installation or design make it very unlikely that a common cause could exist.

5) Elderly drivers appear to be over represented which should not be the case if a mechanical cause existed.

6) Almost all makes of cars have experienced incidents indicating that a GM design fault could not be the cause.

7) "Drivers perceptions of the events which occurred may be incorrect", particularly since it is a frightening new experience requiring rapid decision making to prevent great harm to themselves or others.

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The report concludes that "inadvertent and unknowing driver application of the accelerator pedal when the driver intended to apply the brake appears to be the cause of many of the reported sudden acceleration related accidents, even though many of the drivers continue to believe that they had been pushing on the brake pedal".

3. JAPANESE GOVERNMENT

In April of 1988, the Japanese Ministry of Transport published a report providing an analysis of some 261 incidents of unexpected vehicle behavior of which some 70 can be presumed, in the absence of detailed investigation reports, to fall under the definition of S.A. used in this report. The remainder can be broadly described as failure to return to idle, admitted driver errors, or problems occurring as a result of detectable vehicle malfunctions. The results of the analysis was that there was no common factor in the incidents in that they involved a variety of manufacturers' vehicles spanning a number of years, employing varying designs of carburetor or fuel injected engines, and differing brake system designs.

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Other factors such as weather, season, time of day, operator sex and age, place of occurrence were equally randomly distributed. The only factor of real interest was that some 30% of the involved drivers had less than 6 months experience in the vehicle in question although only 1% had less than 6 months total driving experience.

The remainder of the report provides details of tests performed on selected vehicles and the analysis of the fuel delivery and brake systems. As the results are identical for all practical purposes to those already discussed in the GM and Audi cases it would be redundant to repeat them. One area that is covered in considerably more detail is the question of electromagnetic radiation interference with electronic engine control components. This esoteric field has been proposed as a potential cause or contributor to S.A. events. The report clearly indicates that even outrageously powerful signals are incapable of causing the bombarded systems to malfunction in an unsafe manner.

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The report concludes that "even though there were rises in engine speed due to the factors discussed above, (though only cruise control malfunctions were demonstrated to be capable of SA case reported speeds - and these remain detectable), a loss in brake performance was not observed". The authors go on to recommend improved fail safe designs for electronic components as well as improved quality control checks for these same components.

It is the intention of the Japanese government to continue the investigation concentrating on the human factors aspects of the driving task. Also worth noting is the agreement by all Japanese motor vehicle manufacturers to provide "shift-lock" devices on all automatic transmission vehicles sold into their domestic market starting in 1989.

4. RELATED INVESTIGATIONS

One further subject requires detailed discussion in this section - namely cruise control systems. A cruise control system, by virtue of its capability to open the throttle without direct operator input, has the potential to produce unexpected acceleration but, it cannot affect the ability of the braking system to stop the vehicle. A number of

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investigations into cruise control failures, both simulated and actual, have been undertaken over the years. One recent example, carried out by Swedish Defence Research Establishment has received some publicity in which it is indicated that the potential failure uncovered could cause incidents of S.A. This is incorrect. The malfunction introduced into the system would only open the throttle when the brake was released and was immediately cancelled by reapplication of the brake. Regardless of this, the fact that similar, if not identical failures have occurred in consumer owned vehicles has led to a number of recalls and at least one current investigation.

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SECTION III

PRESENT INVESTIGATION

As discussed in the previous section, Transport Canada has, in the course of investigations, carried out dynamic vehicle tests, disassembled vehicles involved in S.A. incidents, thoroughly investigated and reconstructed S.A. accidents, simulated various vehicle system failure modes and analyzed the results of studies undertaken in several countries. The present study involved reviewing all previous studies and then capturing as much data as possible from the 245 complaints classified as S.A. incidents in the Defect Investigation Division database. Next a computer program was written to analyse the data and present the results. Due to the fact that a number of early complaints were not fully documented as regards specific driver or vehicle characteristics, the total number of data points available varies from graph to graph. Also, it should be noted that only complaints investigated by Transport Canada are included even though the Defects Investigation division may be aware of additional incidents reported to individual manufacturers. The significant information is presented in the following graphs found in the Appendix:

- Graph 4 provides information on the number of incidents by manufacturer per 100,000 vehicles in the fleet.

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- Graph 5 expands the information for those manufacturers with multiple model involvement.

- Graph 6 plots driver's age versus percentage of drivers in that age group in the general population.

- Graph 7 plots driver experience with the vehicle in question versus percent of incidents

- Graph 8 provides male/female incident percentages versus the breakdown in the general population.

- Graph 9 shows how the incidents were terminated.

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DISCUSSION:

1. Graph 4 must be viewed with caution, small fleet size will overemphasize one or two incidents.

2. The fact that Honda and VW/Audi are over-represented must be considered in relationship to the amount of publicity these investigations received.

3. The present study does not indicate that older drivers are over-represented nor that sex of the driver is important.

4. Graph 7 shows quite clearly that drivers new to a vehicle are much more likely to experience an S.A. incident. Indeed, over 18% of all incidents involved drivers who had driven the vehicle in question for under 1000 kilometers.

CONCLUSION:

The present study, and all others known to Transport Canada, confirm that "sudden acceleration", as defined in the introduction to this report, occurs as a result of driver error.

APPENDIX

MANUFACTURER
AND MODEL CODES

MANUFACTURER:

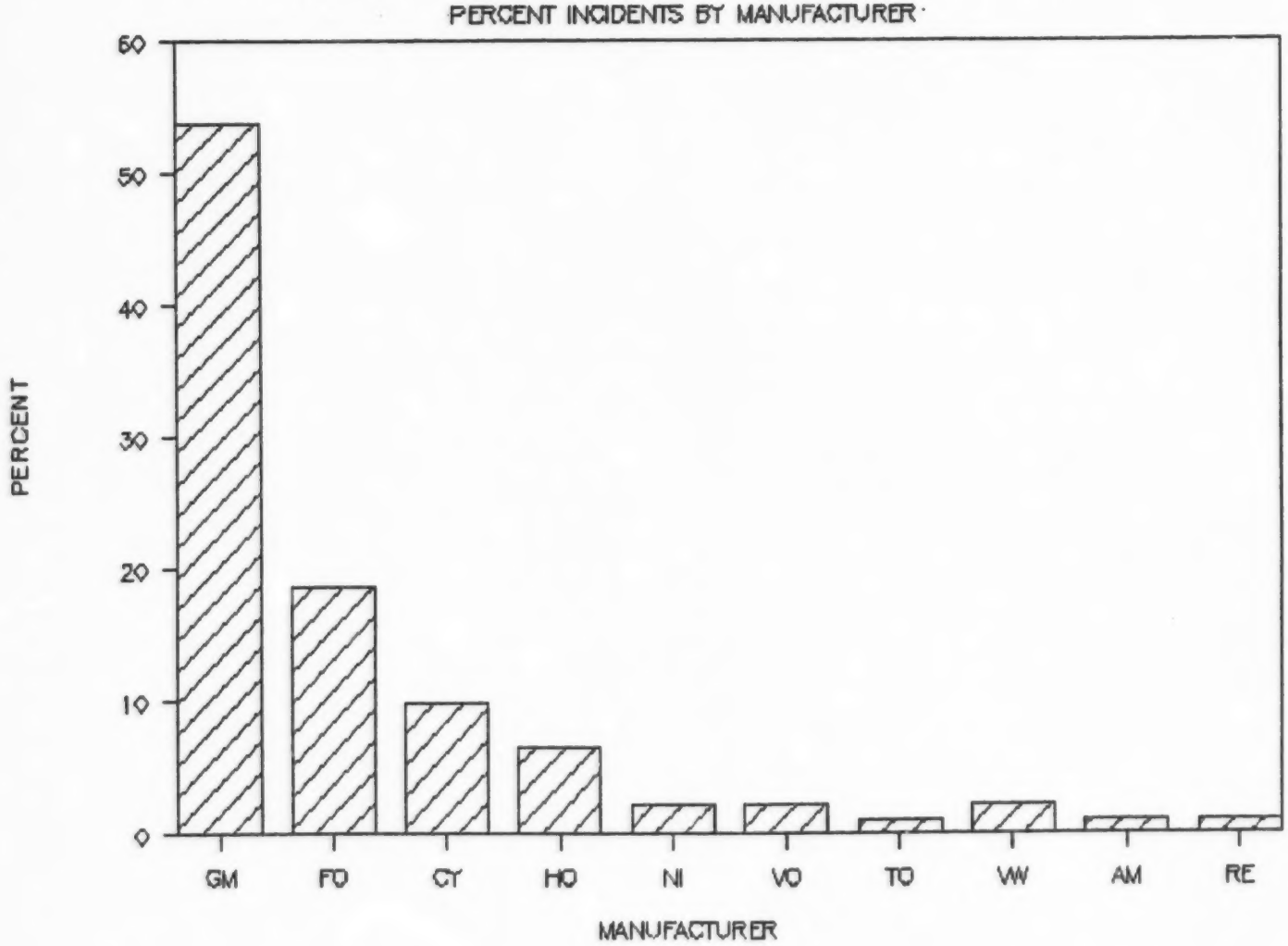
GM - General Motors
FO - Ford
CY - Chrysler
HO - Honda
NI - Nissan
VO - Volvo
TO - Toyota
VW - Volkswagen/Audi
AM - American Motors
RE - Renault
SU - Subaru
MA - Mazda
ME - Mercedes
HY - Hyundai
JA - Jaguar

MODELS:

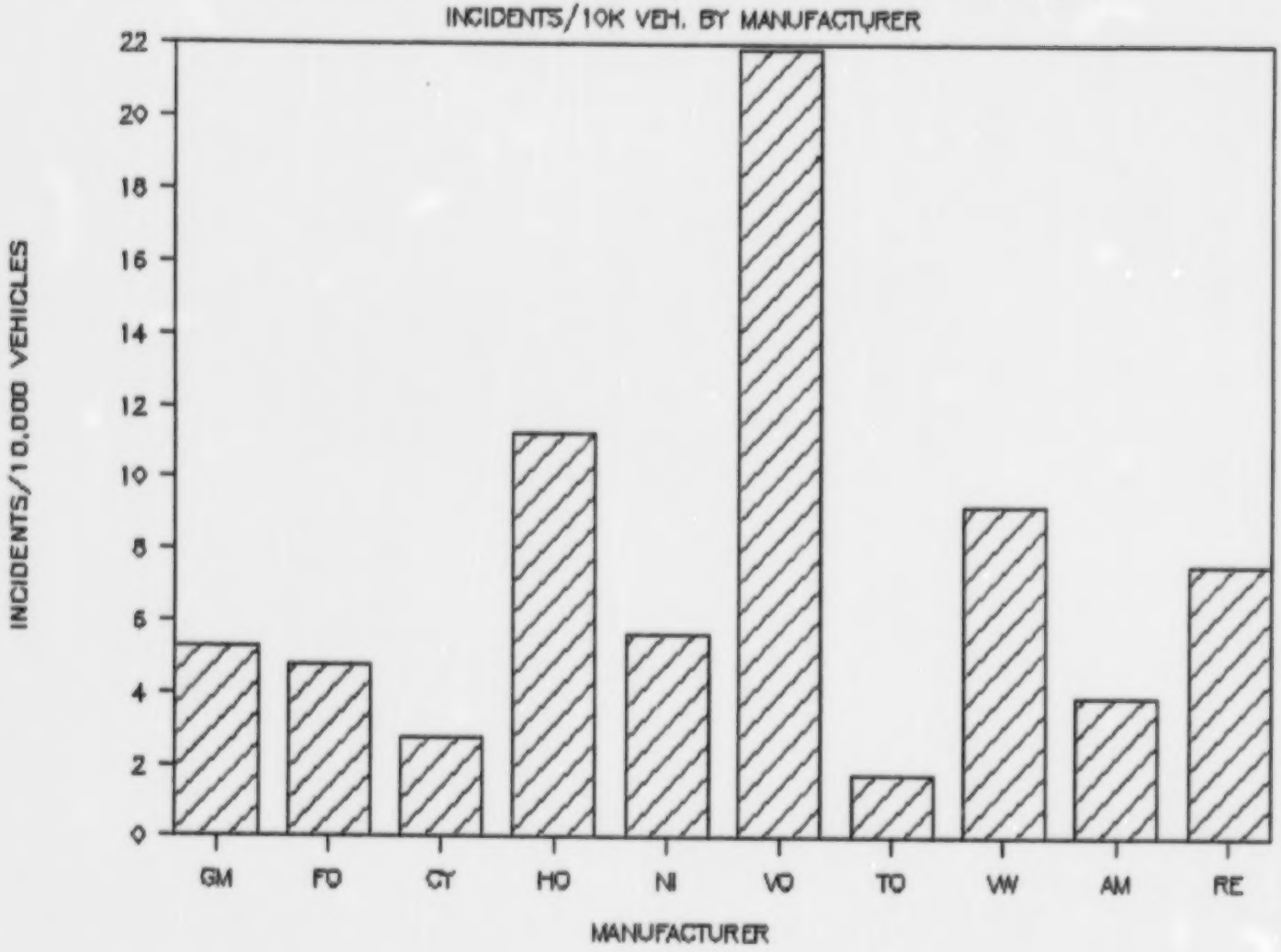
CH - Chevrolet
PO - Pontiac
OL - Oldsmobile
BU - Buick
CA - Cadillac
GC - GMC Trucks
FO - Ford
MR - Mercury

CY - Chrysler
DO - Dodge
VW - Volkswagen
AU - Audi

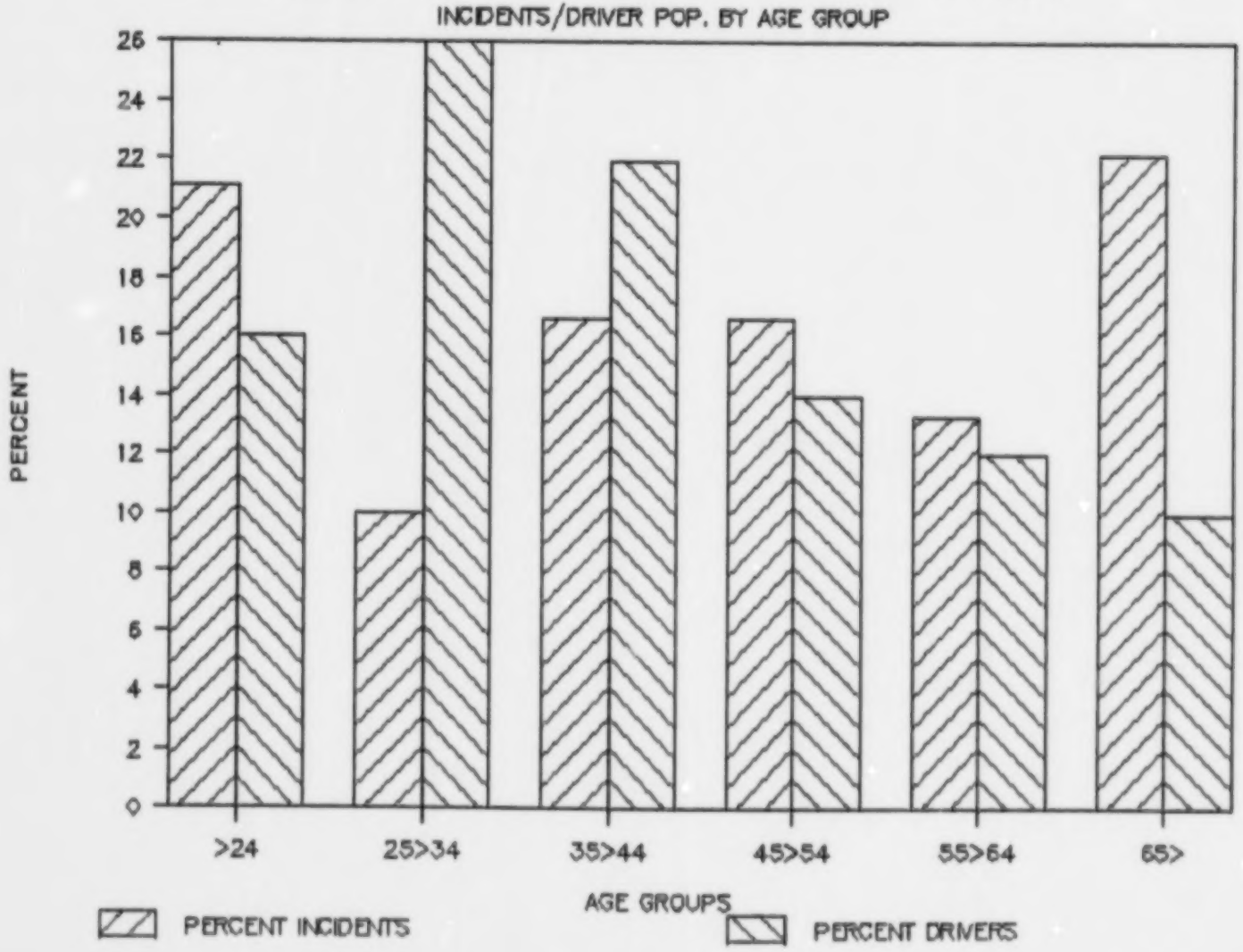
GRAPH 1: OTTAWA/CARLETON STUDY



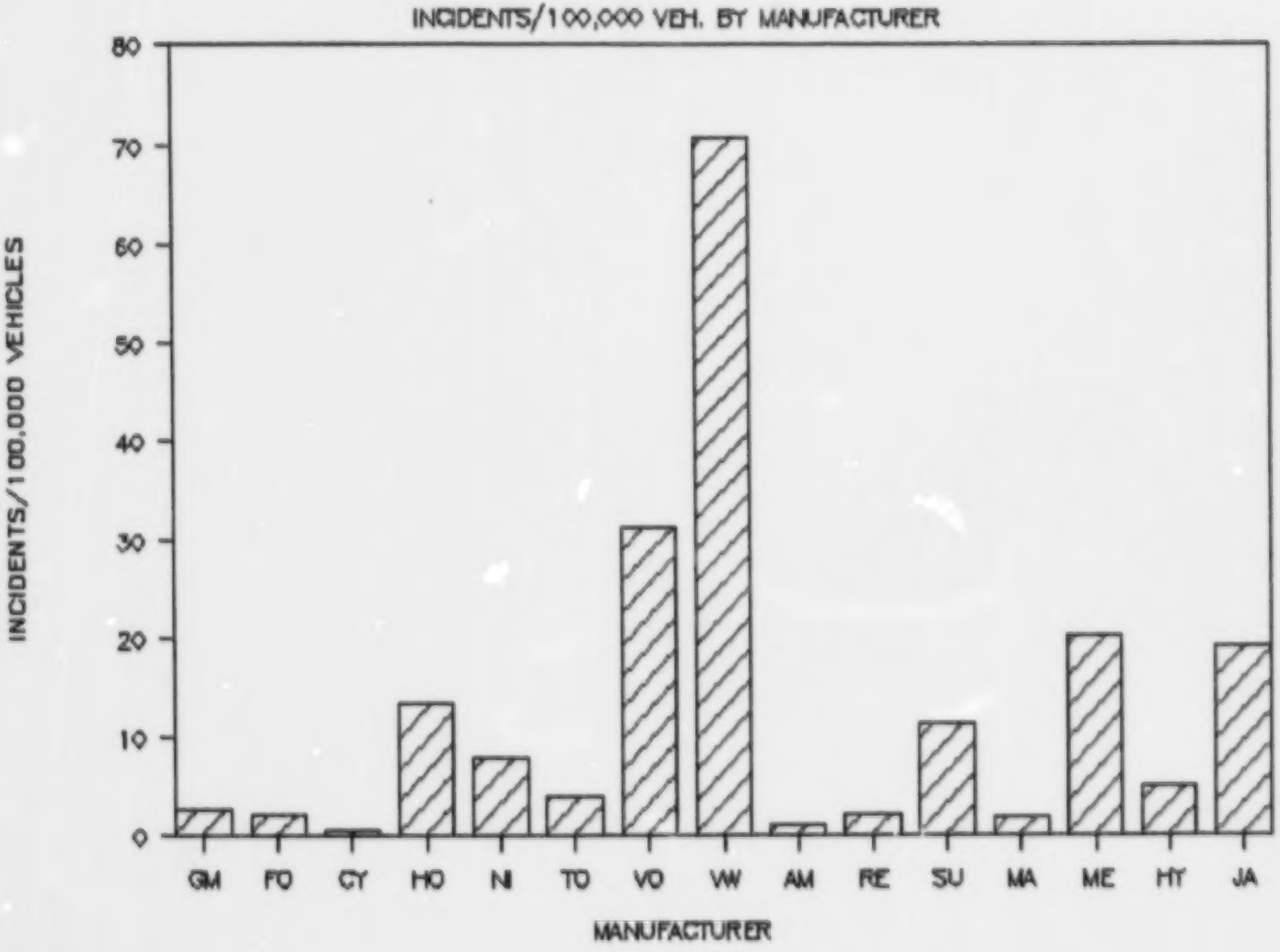
GRAPH 2: OTTAWA/CARLETON STUDY



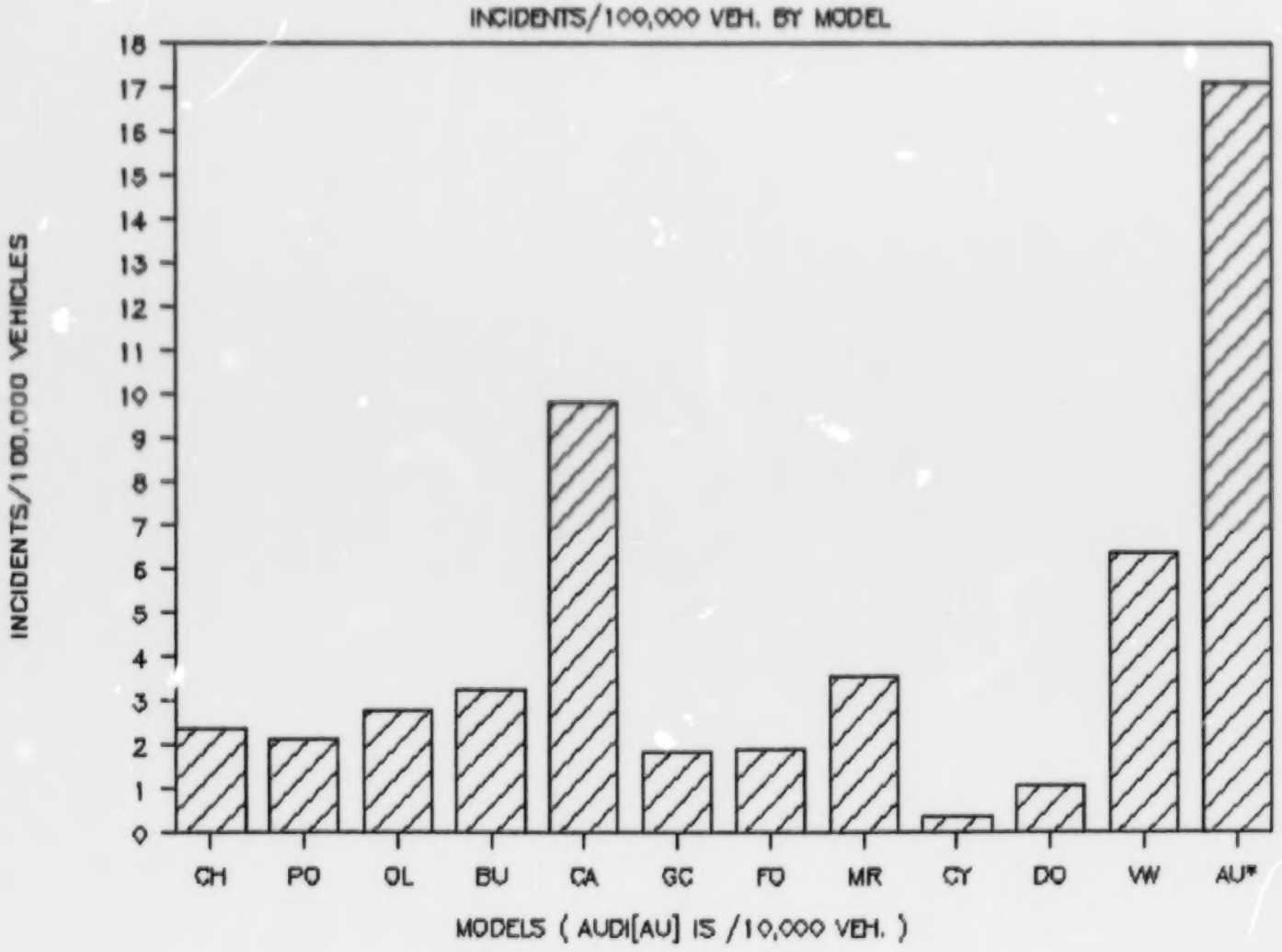
GRAPH 3: OTTAWA/CARLETON STUDY



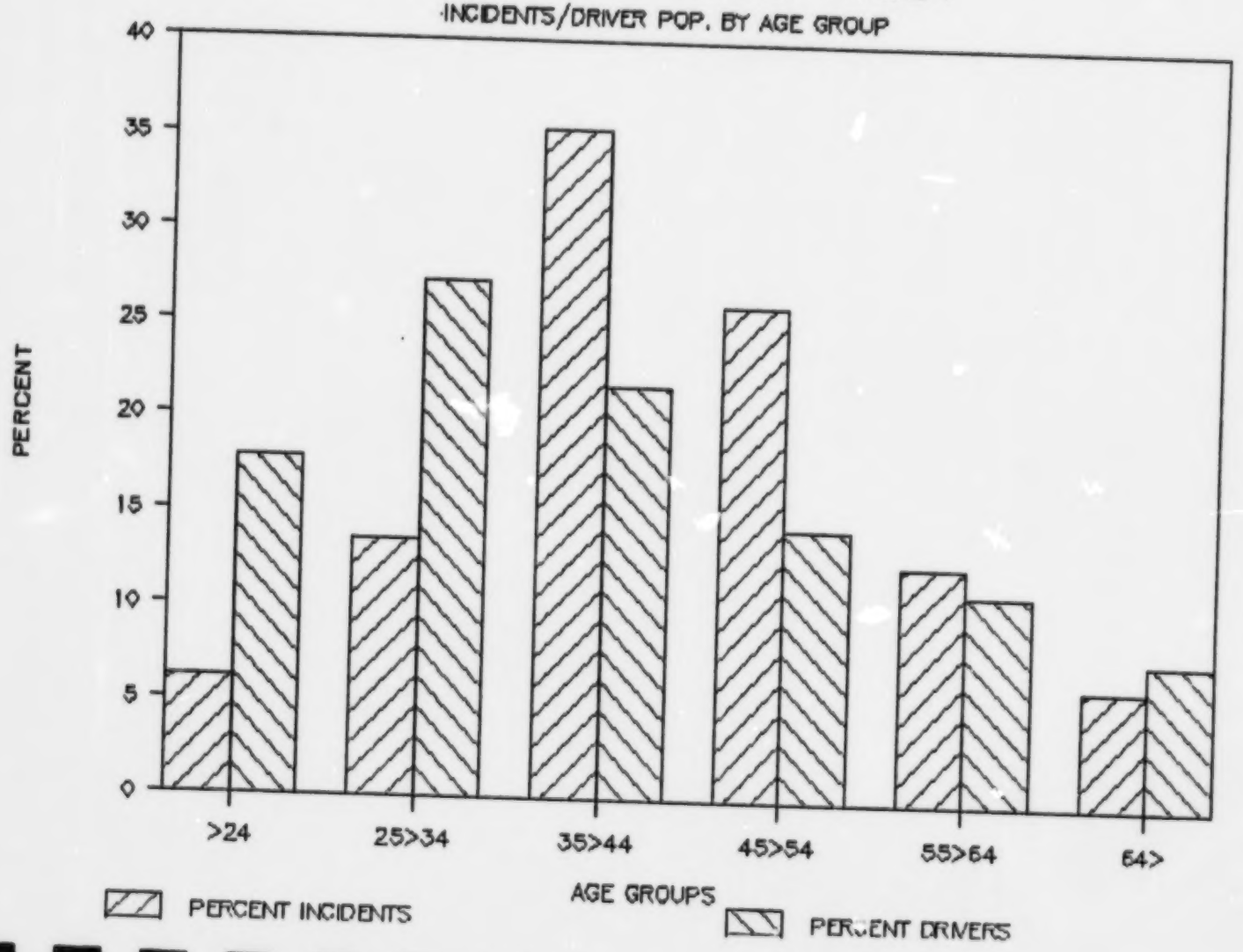
GRAPH 4: PRESENT STUDY



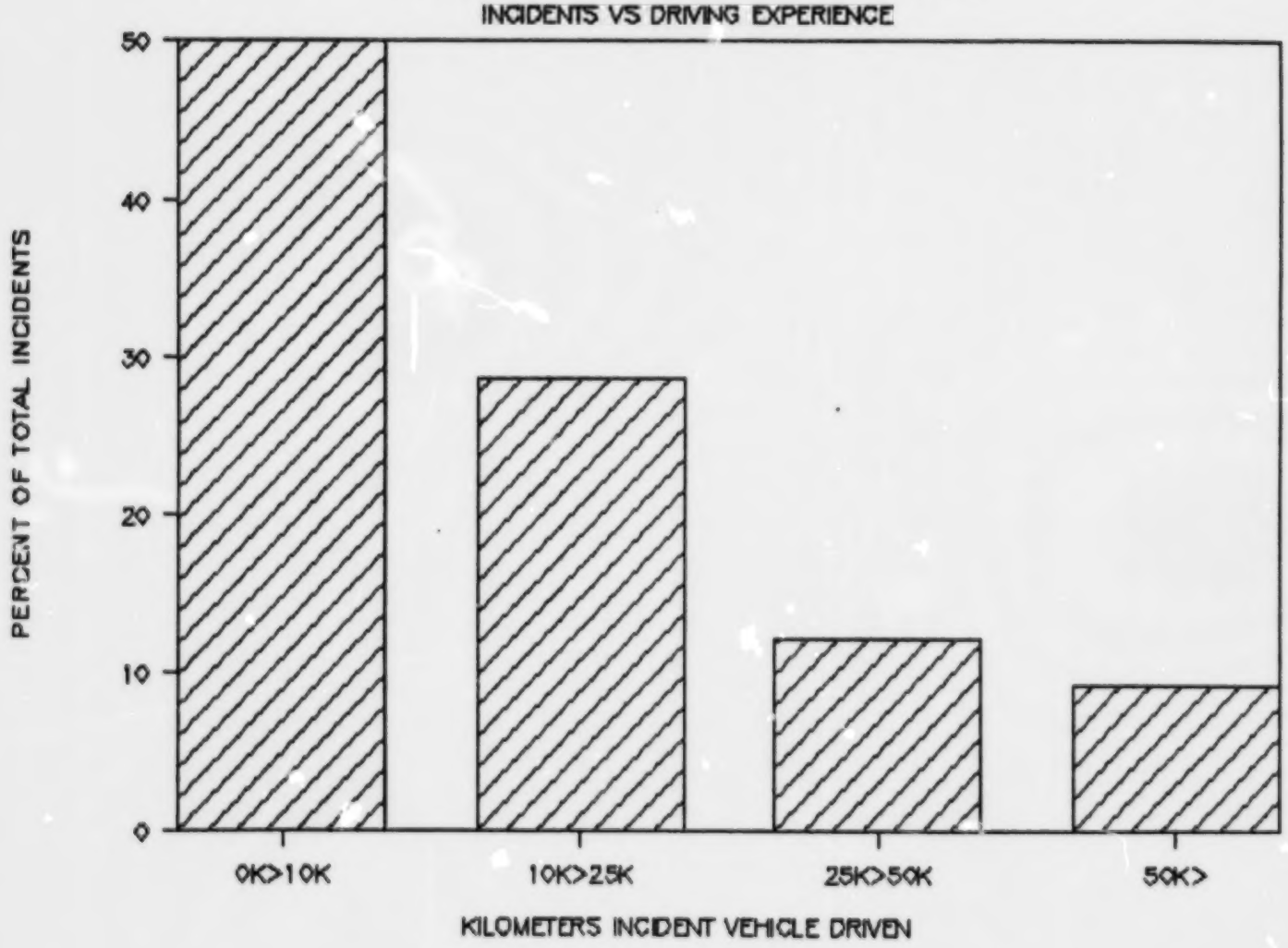
GRAPH 5: PRESENT STUDY



GRAPH 6: PRESENT STUDY

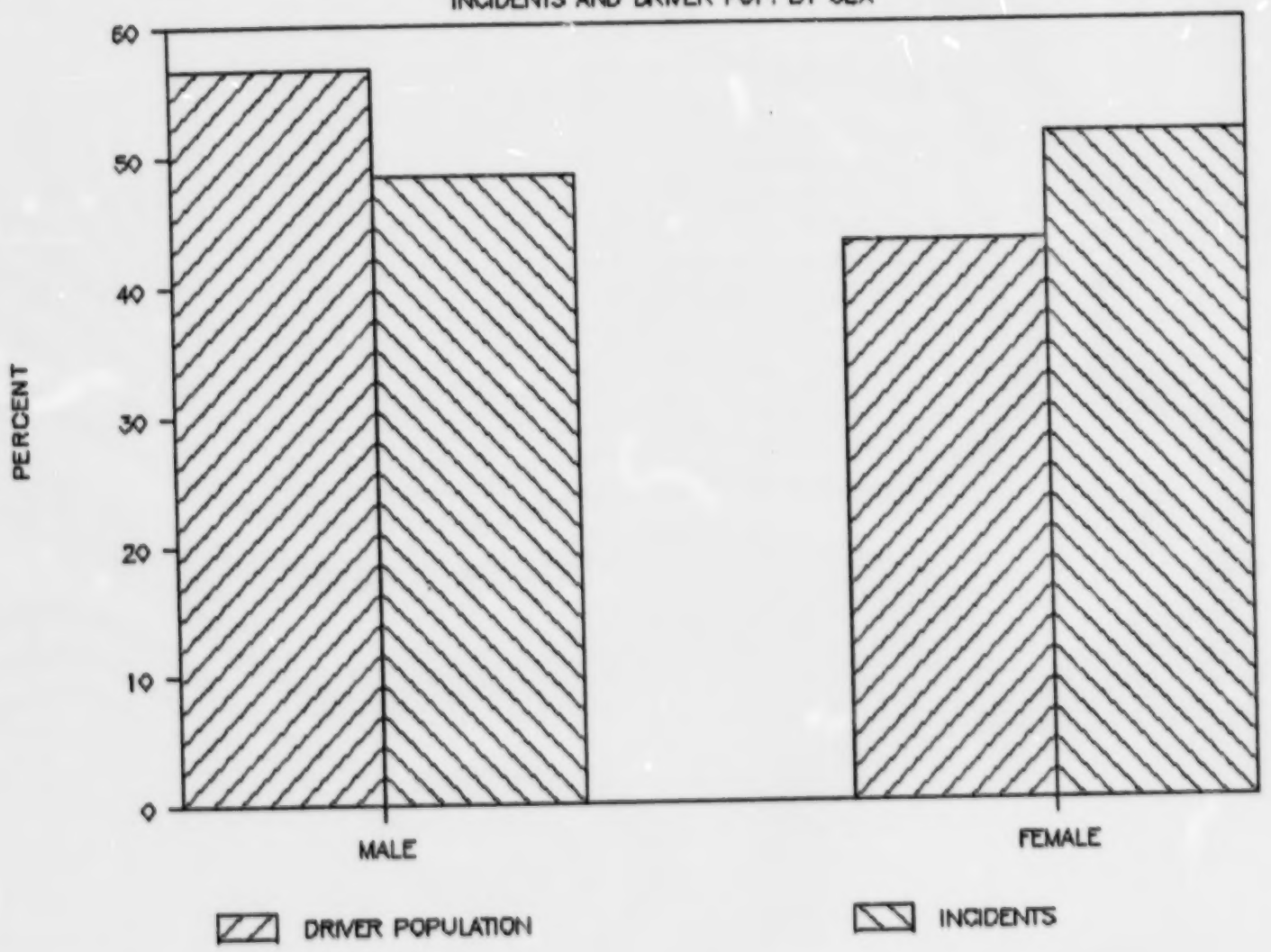


GRAPH 7: PRESENT STUDY



GRAPH 8: PRESENT STUDY

INCIDENTS AND DRIVER POP. BY SEX



GRAPH 9: PRESENT STUDY

HOW INCIDENT TERMINATED